A Review: Experimental Investigation on LSAW large diameter pipes using the J-C-O process

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***Abstract*- This Article Considers Analysis Procedures for Longitudinally Submerged Arc Welded Steel Pipes(LSAW), Via Control of high forming accuracy and efficiency as well as balanced distribution of forming stress. J-C-O manufacturing technology is developed in the 1990s as a pipe forming process, the process of moulding process is the first major steel mill edge (or planning) after pre-bending by longitudinal side, and then type → J→ C→ O-order moulding, stamping each step are the basic principles of three-point bending. Considered as one of the most significant moulding process. The deformation characteristics of JCOE forming are analysed, in which the geometry of the formed pipe, residual stress distributions and effects of process parameters on JCOE forming quality can be obtained. LSAW (Longitudinally Submerged Arc Welded Steel pipes) in leaflets plate as raw material, the steel plate in the mould or moulding machine pressure (volume) into using double-sided submerged arc welding and flaring from production. J-C-O forming process based on the help of the new technology the ideal LSAW forming pipe is obtained in only 13 steps. The project aim is to effective approach to improve welding pipe forming quality and increase the strength of joint and productivity is significantly increased.**

Index Terms- Longitudinally Submerged arc Welded(LSAW) pipes, J-C-O/J-C-O-E Process(Forming Process),Mechanical Properties. Corrosion Test.

I. INTRODUCTION

LSAW (Longitudinal double submerge arc welding) carbon steel pipe is a type of SAW pipe made of steel plates that were hot rolled by JCOE or UOE forming technology. JCOE technology represents the shaping and forming processes involved during manufacturing as well as the inner and outer welding and cold expansion carried out after welding.

When compared to UOE LSAW steel pipes, LSAW pipe manufacturers in China can produce more sizes as thus: OD 406 mm – 1620 mm, thickness 6.35 mm – 60 mm, pipe length 2 m – 18 m with the LSAW pipe having superiority.

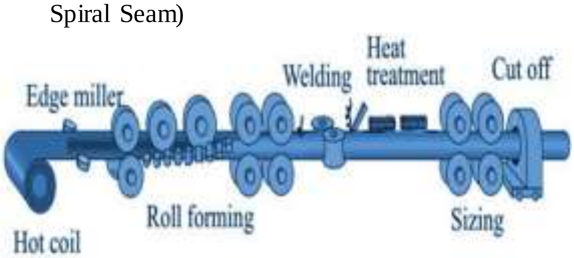
Seamless pipe is Strongest amongst all pipes type as it has a Homogeneous structure throughout pipe length.

▪ Seamless pipes are manufactured in a verity of size and schedule. However, there is a Restriction on the manufacturing of large diameter pipe. Seamless pipes are widely used in the manufacturing of pipe fittings such as bends, elbows, and tees.

▪ Various Manufacturing process are explained:

1.1 Mandrel Mill Process
1.2 Mannesmann Plug Mill Pipe Manufacturing Process
1.3 Forged Seamless Pipe Manufacturing Process
1.4 Extrusion Processes
1.5 Welded Pipe Manufacturing Process

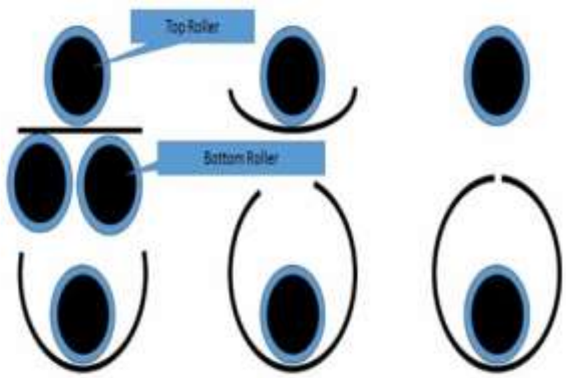
- There are different welding methods used to weld the pipe.
- ERW- Electric Resistance Welding
- EFW- Electric Fusion Welding
- HFW- High-frequency welding
- SAW- Submerged Arc Welding (Long seam & Spiral Seam)



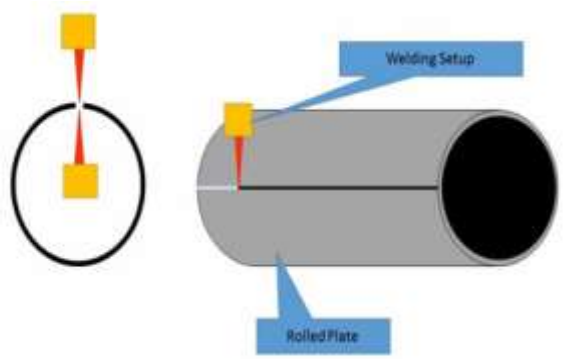
SAW Pipe Manufacturing Process

In SAW welding process, external filler metals (wire electrodes) are used to join the formed plates. SAW pipes can have a single longitudinal seam of double longitudinal seam depend on the size of the pipe. SAW pipe are also available in the spiral seam, which is continually rolled from the single plate coil. The production rate of spiral SAW pipe is very high as compared to Straight SAW pipe. However, Spiral SAW pipe are only used in low-pressure services such as water, non-critical process services etc.

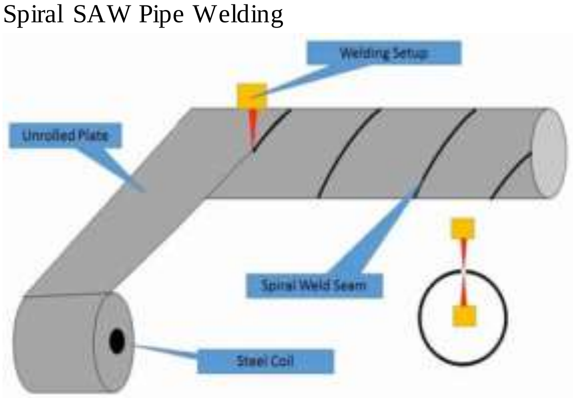
Plate Rolling



Straight SAW Pipe Welding



Spiral SAW Pipe Welding



II. LITERATURE REVIEW

Giannoula C et al.(2016) [1] works on Finite element analysis of UOE manufacturing process and its effect on mechanical behavior of offshore pipes, The present study examines the effect of UOE line pipe manufacturing process on the structural response and resistance of offshore pipes during the installation process using advanced finite element simulation tools. The cold bending induced by the UOE process is simulated rigorously and, subsequently, the application of external pressure and structural loading (bending or axial force) is modeled, until structural instability is reached. In the first part of the paper, the UOE cold-bending manufacturing process steps are simulated in detail. The analysis is based on a 24-in. (609.6 mm) diameter pipe with nominal thickness equal to 32.33 mm (1.273 in.) and adopts the forming geometrical parameters of a case study introduced elsewhere.

Tianxia Zou et al.(2015) [2] work on A numerical method for predicting O forming gap in UOE pipe manufacturing, Large diameter welded pipes used in oil and gas pipelines are primarily manufactured by the UOE process, which consists of U forming, O-forming, and expansion procedures. The formation of O-forming gap in the O-forming stage is a key processing factor and it involves complex plastic deformation and springback of the steel plate. In this paper, a numerical method is proposed for predicting geometric configuration and O-forming gap of steel plate after C–U–O-forming. A numerical method for predicting O-forming gap in UOE manufacturing is presented. The formation mechanism of O-forming gap is unveiled. The influence of processing parameters on O-forming gap is studied. UOE parameter design can be carried out efficiently based on the proposed method. O-forming gap can be well controlled by the optimization of UOE parameter design.

Fan LF et al.(2015) [3] Multi-objective optimization of crimping of large diameter welding pipe, the results provide an effective approach for improving crimping quality and reducing design times. Crimping is widely adopted in the production of large-diameter submerged-arc welding pipes. Traditionally, designers obtain the technical parameters for crimping from experience or by trial and error through experiments and the finite element (FE) method. However, it is difficult to achieve ideal crimping quality by these approaches. To resolve this issue, crimping parameter design was investigated by multi-objective optimization.

Fan LF et al.(2015) [4] Robustness design for crimping of large diameter straight welded pipe, To improve crimping forming quality, this paper investigated crimping which was simulated using the FE code ABAQUS and the FE model was validated experimentally. The research results show that the optimization design scheme can improve the product performance, and increase the reliability from 4.2% to 97.7% and ensure the product quality. Thus, the results herein provide an effective approach for crimping parameter design

Fan LF et al.(2012) [5] Quality control on crimping of large diameter welding pipe., Crimping is used in production of large diameter submerged-arc welding pipes. Many researches are focused on crimping in certain manufacturing mode of welding pipe. The sensitivity analysis indicates that the effects of length of crimping, technical parameters of punch on forming quality are significant. In particular, the data from simulation analysis are regressed by response surface method (RSM) to establish prediction model. The feasible technical parameters are obtained from the prediction model. This method presented provides a new thought used to design technical parameters of crimping forming and makes a basis for improving crimping forming quality.

Zhao Jun et al.(2011) [6] work on Study on intelligent control technology for forming steel pipe of pipeline with JCO process and By employing the intelligent control technology of JCO process, and combining with the error compensation technology between bending steps, the ellipticity of the formed pipes is less than 1.5% and the high-quality pipes can be manufactured without the operator’s experience. Based on plastic bending engineering theory and machine vision technology, the intelligent control strategy for forming the steel pipe with JCO process is presented. And an intelligent control system for forming the steel pipe is developed.

Zhao Jun et al.(2011) [7] work on Four-point bending JCOE process: A new technology for forming longitudinally submerged arc welding pipe, Based on the analysis of the mechanical principles of the "four-point bending JCO(J-Forming C Forming O-Forming)" process for LSAW(longitudinal submerged arc welding) pipe as well as theoretical and experimental researches on "compression to make round" ,this paper presented a new technology called the "four-point bending JCOC(J Forming C-Forming O-Forming and Compression to make round) process". The advantages of the new technology included fewer steps of formation, higher productivity, the dispensing with crimping process, less residual stress, higher flexibility, better forming quality and preventing the expansion of flaws. Scaling down the mold and pipe dimensions in accordance with the principle of similarity, this experiment used the new technology to make Φ260.4mm×4.7mm pipe samples from Φ1219mm×22mm of X80 steel pipe. The samples made by the new process met production requirements with the ovality up to 0.5%.This indicated that the new technology had good marketing and engineering applications.

Gao Y et al.(2010) [8] Finite element analysis of JCO forming process for longitudinal seam submerged arc welded pipes, This paper presents a study of spring back in the JCO forming process for welded pipe with diameter 1067 mm, wall thickness of 19.1 mm of X70 based on the plate bending theory by the method of FEM analysis combining with production practice. The results from the simulations compared with those from practical production, good correlation being achieved. The work shows that the finite-element method can be used to predict JCO geometry. The relationship between punch displacement, the bending angle under loading and after spring back, and spring back angle is deduced and can be used to optimise process parameters and guide the production practice.

M.D.Herynk et al.(2007) [9] presented Effects of the UOE/UOC pipe manufacturing processes on pipe collapse pressure, Large-diameter pipes used in offshore applications are commonly manufactured by cold-forming plates through the UOE process. The plate is crimped along its edges, formed into a U-shape and then pressed into an O-shape between two semicircular dies. The pipe is welded closed and then circumferentially expanded to obtain a highly circular shape. Collapse experiments have demonstrated that these steps, especially the final expansion, degrade the mechanical properties of the pipe and result in a reduction in its collapse pressure upwards of 30%. Increase in the O-strain and decrease in the expansion strain improve the collapse pressure. Substituting the expansion with compression can not only alleviate the UOE collapse pressure degradation but can result in significant increases in collapse performance.

Palumbo G AND Tricarico L(2005) [10] work on Effect of forming and calibration operations on the final shape of large diameter welded tubes. Large welded tubes are primarily used in oil pipelines and offshore platforms. They are actually produced by the steelmaker industry ILVA-Laminati Piani, Taranto (Italy). The production process is characterized by three phases: (1) forming; (2) welding and (3) calibration. In addition, the first phase is composed by three steps: the forming of the longitudinal border of the blank (C-forming); the air bending of the C-formed blank (U-bending) and the forming inside a circular shaped die of the U-formed blank (O forming). After the welding phase, the final forming operation (calibration) is performed to correct the tube distortion due to the thermal input using a special purpose machine (expanding machine).

Liu J et al.(2005) [11] work on Effects of the parameters of prebending on Oforming of pipe in UOE process, Detailed finite element analyses were conducted on the effects of prebending parameters, prebending angle and prebending radius, on the O-forming in UOE process for welded pipe. The analysis shows that prebending process can improve the profile curvature of O-formed pipe. The curvature is markedly improved if the prebending angle exceeds 25. With the increase of the prebending angle, the curvature of O-formed pipe inclines to homogeneous, while the forming force increases with the prebending angle. The profile of O-formed pipe can be optimized when the prebending radius is within 1.0 to 1.3 times nominal radius of pipe line. The curvature markedly changes along profile if larger or smaller radius is adopted. In the case of constant compress strain, the forming force is larger at the above favorable radius. However, in the case of constant forming force, the above favorable radius is still more favorable on the profile of pipe.

III. RESEARCH GAP

• After studying the research paper, many researches now focus on the UOE forming process, and the JCOE forming process was less widely noticed. In the early stage, the researches depended on experiment. Most of papers were related to crimping and calibration, few related to JCO forming. Although the results are useful to guide production, they are difficult to promote in further and lack of universality.

• The analytical method based upon simplifications of process and material behaviour is adopted to study the crimping, calibration and air bending in JCO forming process. The analytical method upon simplifications of process and material behaviour is adopted to study the crimping, calibration and air bending in JCO forming process. The analytical method generally has to be formulated with significant simplifications of forming conditions which can considerably affect the accuracy of the results. Finite element analysis (FEA) is an efficient tool for researching JCOE forming process.

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